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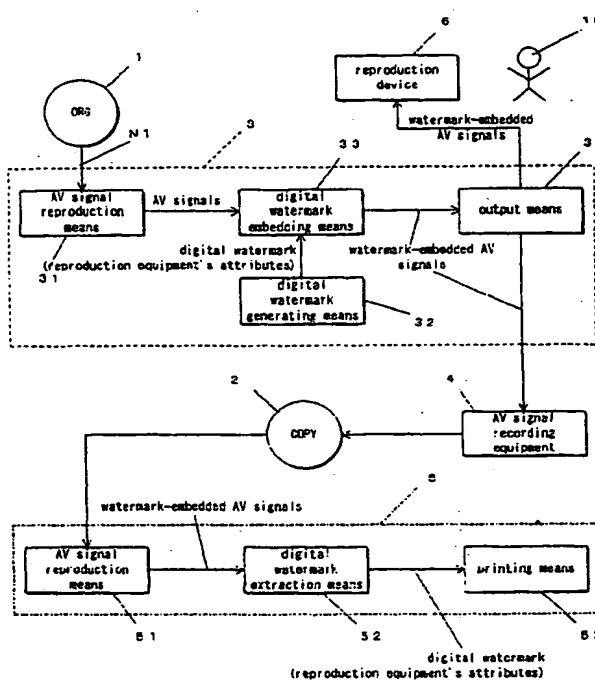
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(54) Audio/visual reproduction apparatus and method with equipment identification code insertion

(57) Audio/visual reproduction equipment (3) converts an identification code of the reproduction equipment into a plurality of signal sequences using a correspondence table and embeds the obtained plurality of signal sequences in audio/visual signals as a digital watermark. Audio/visual reproduction equipment identification apparatus compares correlation values of the audio/visual signals containing the digital watermark embedded therein with all signal sequences contained in a correspondence table. A comparison of the correlation values with a previously set threshold value determines the embedded signal sequences and thus the identification code of the audio/visual reproduction equipment which may be extracted.

Fig. 1



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Description

[0001] This invention relates to reproduction equipment for audio/visual signals. In the present specification, the term "audio/visual" signals refers to audio or video signals or both audio and video signals (the form in which these coexist is immaterial). To be more specific, the invention relates to apparatus for embedding an identification code, which identifies the reproduction equipment, as a digital watermark in audio/visual signals (reproduced signals) output from reproduction equipment.

[0002] This invention also relates to apparatus for identifying the reproduction equipment on which signals have been reproduced for recording, which extracts a digital watermark from reproduced audio/visual signals, and which identifies the reproduction equipment on which the audio/visual signals were reproduced (reproduced signals).

[0003] In the present Specification, "reproduction equipment" refers not just to equipment that has only the function of reproducing audio/visual signals from a recording medium (playback) but refers also to equipment having both the function of reproduction and the function of recording audio/visual signals in a recording medium, and to apparatus for reproducing audio/visual signals from broadcast signals or from signals delivered via cable or telephone line.

[0004] Recently, it has become possible to record and reproduce audio/visual data in various forms. Audio/visual data can be recorded and reproduced as analogue signals, as in the case of VHS, or recorded and reproduced as digital signals, as in the case of DVD.

[0005] Also, the audio/visual data may consist of just audio signals or video (moving pictures or still pictures) signals and can be recorded and reproduced as analogue signals or digital signals.

[0006] This invention can be applied to audio/visual data of any signal form.

In particular, digital contents (audio/visual data in the form of digital signals) have come to be used widely recently.

[0007] Regardless of whether the data are recorded and reproduced as audio/visual signals and in analogue or digital form, if the data have the property of being an authored work, the copyright thereof must be protected. The prohibition of illegal copies is especially important.

[0008] Although audio/visual data in the form of analogue signals can be copied, the degradation of quality (sound quality or picture quality, etc.), with each generation, cannot be avoided when copying is performed. It can thus be said that repeated copying of analogue audio/visual data cannot be performed satisfactorily.

[0009] However, quality degradation from copying does not occur at all with digital content. In other words, a copy that is exactly the same as the original is easy to make.

[0010] Since illegal copies of content (or content that

originates from such content and is distributed) cannot be distinguished from the original, it is difficult to provide evidence that proves their illegality. The establishment of technical methods that enable effective protection of copyright is thus being sought.

[0011] The use of "digital watermarks" is being examined as such a method.

A "digital watermark" consists of data that are embedded in audio/visual signals in a manner that is imperceptible to a viewer or listener and are devised so that the digital watermark can be extracted from the audio/visual data in which it is embedded.

[0012] Copyright information (for example, the name of the copyright holder, date of copyright, etc.) are embedded in audio/visual data as a watermark for protection of the copyright.

[0013] By extracting the embedded digital watermark (copyright information) from audio/visual data suspected of having been copied illegally, the copyright owner of the content can be seen and the illegality of a copy is exposed. In such a manner, digital watermarks are intended to prevent illegal copies.

[0014] Specific techniques for embedding a watermark in audio/visual data are described in detail, for example in "The Fundamentals of Digital Watermarks - A New Protection Technology for Multimedia" by Kashio Matsui (Morikita Publishing, 1998), etc.

[0015] Japanese patent publication No. 2982768 also discloses the prevention of illegal copying of content by embedding a digital watermark in audio/visual signals.

[0016] In the art described by this literature, an illegal copy prevention signal is embedded in advance as a digital watermark in the audio/visual signals.

Extraction of the illegal copy prevention signal from the audio/visual signals is then performed during the reproduction of the audio/visual signals. If the copy prevention signal has been extracted when the audio/visual signals are recorded, noise is added as a new digital watermark.

[0017] Thus each time an illegal copy of a recording medium, based on the above art is viewed or listened to, noise is added to the audio/visual signals. This degrades the quality (sound quality or visual quality) of the audio/visual signals each time the signal is reproduced or copied. Eventually, such a large amount of noise is added to the audio/visual signals that viewing and listening is impossible. As a result, illegal copying in multiple generations is inhibited.

[0018] With the prior art, the reproduction equipment that was used for copying cannot be identified. This is because, with the prior art, the digital watermark that is embedded in the audio/visual signals is, for example, the name of the author, random noise without meaning, etc. The embedded information has no relationship to the reproduction equipment. Even if the digital watermark discloses the name of the author or copyright owner, this information is of no practical use unless proof can be obtained of the fact that illegal copying was per-

formed.

[0019] If the reproduction equipment that was used for copying can be identified, it can be claimed with a high degree of certainty that the owner or user of the reproduction equipment was involved in illegal copying. However, the prior art is incapable of providing this information.

[0020] Illegal copying therefore cannot be restrained effectively by the prior art. The present invention seeks to provide apparatus which can identify the reproduction equipment used for copying.

[0021] Generally, in extracting the embedded digital watermark in accordance with the abovementioned literature, the values of correlation between all noise strings used in embedding and the signals in which the digital watermark is embedded are determined and the noise string that exhibits the greatest correlation value is extracted as the embedded noise string. However, if the embedded noise string is selected arbitrarily, there may be a noise string that exhibits a high correlation value by chance. In this case, the embedded noise string cannot be extracted accurately. The present invention therefore also seeks to provide apparatus by which the embedded digital watermark can be extracted with high precision.

[0022] In some cases, people who copy audio/visual signals illegally intentionally disable the extraction of the information embedded as a digital watermark. For example, the signal sequence is interchanged or a part of the signal is removed. When such processing is performed, the embedded digital watermark cannot be extracted correctly by the prior art. The present invention seeks to provide apparatus by which a digital watermark can be extracted without fail even when a third party processes the audio/visual signals.

[0023] In some cases, people who perform illegal copying analyze the embedded information or embedding method and intentionally embed a false digital watermark. With the prior art, the protection of the copyright is insufficient when a third party is successful in analyzing the embedded information. The present invention seeks to provide apparatus that contains a countermeasure for cases where a third party is successful in analyzing the digital watermark.

[0024] According to a first aspect the present invention audio/visual reproduction equipment is characterized in that it has a digital watermark generating means including means for generating a digital watermark containing attribute information that identifies the reproduction equipment; a digital watermark embedding means including means for generating watermark-embedded audio/visual signals which embeds said digital watermark in said audio/visual signals; and output means for outputting said watermark-embedded audio/visual signals for reproduction.

[0025] With the above arrangement, audio/visual reproduction equipment that was used for illegal copying can be identified specifically by means of the digital wa-

termark that is extracted from illegally copied audio/visual signals. That the owner, etc. of the identified reproduction equipment has been involved in illegal copying can thus be claimed. A system for copyright protection can thus be established to prevent illegal copying.

[0026] According to a second aspect of this invention, audio/visual reproduction equipment comprising a coded signal input unit (101) for receiving coded audio/visual signals; a decoding unit (102) including means for reproducing said audio/visual signals from said coded signal input unit; an identification code generating unit (103) including means for generating an identification code by which the reproduction equipment can be identified; a digital watermark embedding unit (104) including means for embedding said identification code as a digital watermark in said audio/visual signals input from said decoding unit (102); and an output unit, which outputs audio/visual signals having said digital watermark embedded therein by said digital watermark embedding unit (104).

[0027] The plurality of signal sequences obtained are embedded as a digital watermark in the audio/visual signals during reproduction. With a reproduction equipment identification apparatus, the values of correlation between the audio/visual signals in which the digital watermark was embedded and all of the signal sequences contained in the correspondence table are determined and compared with a previously set threshold value to determine the embedded signal sequences. The identification code of the reproduction equipment is extracted using a plurality of signal sequences obtained from audio/visual signals of at least a fixed length of time T.

[0028] With this arrangement, the identification code of the reproduction equipment used in the copying process can be extracted from the illegally copied audio/visual signals to enable detection and prevention of illegal copying.

[0029] In a third aspect of this invention, the signal sequences with which the cross correlation values are smaller than a previously set value (threshold value of cross correlation) are used as the signal sequences to be embedded.

[0030] With this arrangement, the precision of extraction of the embedded signal sequences by the reproduction equipment identification apparatus is improved and the precision of extraction of the identification code is improved. Identification of the reproduction equipment is thus enabled.

[0031] A plurality of signal sequences may be embedded randomly by the reproduction equipment so that they will be embedded at the same proportion per fixed time T.

[0032] With this arrangement, even where people that perform illegal copying perform the process of extracting parts of the audio/visual signals at fixed intervals, the identification code can be extracted without fail from the illegally copied audio/visual signals to enable identification of the reproduction equipment.

[0033] Preferably, the identification code is converted into a binary bit string. A signal sequences corresponding to the "1"s or the "0"s of the bit string are embedded by the reproduction equipment. The order of the embedded signal sequences does not require a meaning.

[0034] With this arrangement, even where people that perform illegal copying change the temporal sequence of the audio/visual signals, the identification code can be extracted without fail from the illegally copied audio/visual signals to enable identifying of the reproduction equipment.

[0035] The contents of the correspondence table that are held in the reproduction equipment and the reproduction equipment identification apparatus may be changed to be always the same by means of a correspondence table changing signal.

[0036] With this arrangement, even in the case where the embedded signal sequences are leaked to a third party, new signal sequences can be embedded by changing the correspondence table to enable identifying of the reproduction equipment.

[0037] The present invention also comprehends a recording medium when recorded using the method of the invention as defined herein or the apparatus of the inventor as defined herein. In this respect a further aspect of the invention comprises a recording medium bearing signals including a digital watermark containing attribute information by which the reproduction equipment on which the audio/visual signals were produced for recording can be identified.

[0038] The above, and other objects, features and advantages of the present invention will become apparent from the following description read in conjunction with the accompanying drawings, in which like reference numerals designate the same elements.

Fig. 1 is a block diagram of a reproduction equipment identifying system of an embodiment of this invention.

Fig. 2 is a block diagram of the reproduction equipment of the invention.

Fig. 3 is a block diagram of the reproduction equipment identification apparatus of the invention.

Fig. 4 is a flowchart for the reproduction equipment of the invention.

Fig. 5 is a flowchart for the identification code generating unit of the invention.

Fig. 6 is an example diagram of a correspondence table of the identification code bit positions and signal sequences of the invention.

Fig. 7 is an explanatory diagram of the identification code bit positions of the invention.

Fig. 8 is a flowchart for the digital watermark embedding unit of the invention.

Fig. 9 is an explanatory diagram, which shows an example of embedding signal sequences in video signals by the invention.

Fig. 10 is a flowchart for the reproduction equipment

identification apparatus of the invention.

Fig. 11 is a flowchart for the identification-code judgment unit of the invention.

5 [0039] Referring to Fig. 1 a reproduction equipment identification system of the embodiment of this invention includes a reproduction equipment 3 having an audio/visual reproduction means 31. Audio/visual reproduction means 31 is of a type capable of reproducing audio/visual data moving in a direction N1 from an original recording medium 1. The audio/visual signals from audio/visual signal reproduction means 31 are applied to a digital watermark embedding means 33. A digital watermark generating means 32 applies a digital watermark to digital watermark embedding means 33. The digital watermark indicates attribute information by which the recording equipment 3 can be specified. The method of generating the digital watermark may be any conventional method, such as that described in the book introduced in the section on the related arts. What is important is that reproduction equipment 3 can be specified by this attribute information.

[0040] The resulting watermark-embedded audio/visual signals are applied to an output means 34. Output means 34 applies the watermark-embedded audio/visual signals to a reproduction device 6 and to an audio/visual signal recording equipment 4. A copier 10 reproduces the data on original recording medium 1 using the output of reproduction equipment 3. In addition, audio/visual signal recording equipment 4 duplicates the performance of illegal copying onto a copy recording medium 2.

[0041] Copy recording medium 2 is then available as physical evidence of the illegal copying performed by copier 10 (represented by a stick figure of the person doing the copying).

[0042] A reproduction equipment identification apparatus 5 is used to prove the fact that copy recording medium 2 was prepared by copying using reproduction equipment 3. Reproduction equipment identification apparatus 5 includes an audio/visual signal reproduction means 51 which receives the copied output of copy recording medium 2. The output of audio/visual signal reproduction means 51 is watermark-embedded audio/visual signals which are applied to a digital watermark extraction means 52. Digital watermark extraction means 52 derives the embedded digital watermark from the watermark-embedded audio/visual signals, and applies the resulting digital watermark to a suitable reproduction device such as, for example, a printing means 53 for printing the digital watermark on paper. Printing means 53 may be any convenient human-understandable device such as, for example, a computer monitor, TV display. In some applications, a combination of display for immediate review, and a permanent printed record may be desired.

[0043] It is assumed in the following that copier 10 does not have a copyright for recording medium 1 and

that copier 10 can be identified as an owner or user of reproduction equipment 3.

[0044] The form of the signal in original recording medium 1 and copy recording medium 2 is arbitrary and may be either analogue or digital. The form of recording medium of recording medium 1 and copy recording medium 2 is also arbitrary and may be selected freely from among disks, tapes, hard disks, etc.

[0045] In general, reproduction equipment 3 may be of a type that is distributed in large numbers in the market while reproduction equipment identification apparatus 5 is generally owned by an organization that controls the copyright for recording medium 1 or by the police or other authority that exercises control over copyright violations.

[0046] Although, for purposes of illustration, reproduction equipment 3 and reproduction equipment identification apparatus 5 are shown at the same location, reproduction equipment 3 and reproduction equipment identification apparatus 5 normally exist in separate locations. Usually, these equipments also differ in their time of use.

[0047] With the system of this invention, illegal copying by copier 10 can be proven by the process to be described below.

[0048] With the system shown in Fig. 1, when copier 10 performs illegal copying, copier 10 sets original recording medium 1 in reproduction equipment 3, connects reproduction equipment 3 to audio/visual signal recording equipment 4 with a cable, etc., and sets copy recording medium 2 in audio/visual signal recording equipment 4.

[0049] Copier 10 also connects reproduction equipment 3 or audio/visual signal recording equipment 4 to a reproduction device 6 to monitor the audio/visual signals.

[0050] If the audio/visual signals contain both sound and images, reproduction device 6 may be television equipment. If the audio/visual signals contain only sound, reproduction device 6 may be an amplifier and speaker (or headphone), etc.

[0051] As was mentioned above, the audio/visual signals may be either analogue or digital signals, and a reproduction device 6 that is compatible with the form of audio/visual signals used will be used.

[0052] If copier 10 considers monitoring to be unnecessary, reproduction device 6 may be omitted.

[0053] Even if copier 10 monitors the audio/visual signals using reproduction device 6, since the digital watermark data are embedded in the audio/visual data in a manner that is imperceptible to the viewer or listener as was mentioned above, copier 10 cannot normally notice that a digital watermark is being embedded in the monitored audio/visual signals.

[0054] The present invention does not degrade the quality of audio/visual signals by the digital watermark as in the prior art described in the abovementioned patent publication. Thus if copier 10 simply monitors the

audio/visual data recorded in recording medium 1 without performing illegal copying, the monitored audio/visual signals will retain good quality.

[0055] This invention thus excels over the art of the abovementioned patent publication in the point that good quality is maintained as long as only legitimate monitoring is performed.

[0056] It can be readily understood that, when it is clear that the digital watermark extracted from copy recording medium 2 indicates attribute information unique to reproduction equipment 3, the suspicion that copier 10, whose connection as the owner, etc. of reproduction equipment 3, is involved in the illegal preparation of copy recording medium 2 becomes provable.

[0057] Thus with this invention, by embedding attribute information unique to reproduction equipment 3 as a digital watermark in the reproduced audio/visual signals, the copyright of recording medium 1 can be protected effectively.

[0058] From the standpoint of copier 10, since copier 10 cannot perceive that a digital watermark is being embedded even if he/she monitors the audio/visual signals on means of reproduction device 6, the evidence of illegal copying is inscribed in copy recording medium 2 without the knowledge of copier 10.

[0059] A copier 10 who comes to know of these circumstances will thereafter be discouraged to perform illegal copying heedlessly due to his/her understanding of the likelihood of exposure of participation in the illegal deed.

[0060] This invention can thus restrain illegal copying.

[0061] A representative form of coded audio/visual signals is now taken up as an example of the audio/visual signals recorded in recording medium 1 and a preferable embodiment for this type of audio/visual signals is now described in detail.

[0062] Referring to Fig. 2, audio/visual reproduction equipment 3 includes audio/visual reproduction means 31, as previously described. Audio/visual reproduction means 31 includes a coded signal input unit 101 which feeds a coded signal to a decoding unit 102.

[0063] An identification code generating unit 103 applies its output to digital watermark embedding unit 104. The output of digital watermark embedding unit 104 is applied to the input of an output unit 105. Identification code generating unit 103 receives a correspondence table changing signal whose nature and function is described in detail later in this specification.

[0064] With the present example, the coded signal input unit 101 and decoding unit 102 correspond to being the audio/visual signal reproduction means 31 of Fig. 1. Also, the identification code generating unit 103 corresponds to being the digital watermark generating means 32, digital watermark embedding unit 104 corresponds to being the digital watermark embedding means 33, and output unit 105 corresponds to being the output means 34.

[0065] Referring now to Fig. 3, audio/visual signal re-

production means 51 contains an input unit 201 which feeds its output to a correlation value calculation unit 203 in watermark extraction means 52. A signal sequences recording unit 202 feeds its output to correlation value calculation unit 203. Signal sequences recording unit 202 receives a correspondence table changing signal, to be described later. The output of correlation value calculation unit 203 is fed to an input of a comparison unit 205. The output of comparison unit 205 is applied to an input of an identification code judging unit 206. The output of identification code judging unit 206 is fed to an identification code output unit 207 in printing means 53.

[0066] With the present example, input unit 201 corresponds to the audio/visual signal reproduction means 51 of Fig. 1, the signal sequences recording unit 202, correlation value calculation unit 203, threshold value setting unit 204, comparison unit 205, and identification code judgment unit 206 and all component parts of the digital watermark extraction means 52, and identification code output unit 207 corresponds to the printing means 53.

[0067] The correlation value calculation unit 203 determines correlation values $S(k)$ defined as follows:

$$S(k) = (X_i \times N_i(k)) \quad (i = 1, 2, \dots, l)$$

where:

X : the audio/visual signal sequences that is input
 N : all of the signal sequences in the correspondence table; e.g. $N(k)$ $k = 1, 2, \dots, m$
 m : the number of signal sequences in the correspondence table

[0068] The reproduction method by which an identification code is embedded as a digital watermark in the audio/visual signals is now described with reference to the flowchart of Fig. 4 which illustrates the process performed by the reproduction equipment of Fig. 2 in embedding the identification code as a digital watermark.

[0069] Coded signal input unit 101 acquires coded audio/visual signals by readout from a recording medium (for example, a DVD, DV, HDD, etc.), receiving of a broadcast, or downloading from a network (for example, the Internet). Coded signal input unit 101 sends the coded audio/visual signals to decoding unit 102 (step 301). Decoding unit 102 then decodes the coded audio/visual signals in accordance with the rules of compression, transmission protocol, etc. and generates base-band audio/visual signals (step 302).

[0070] The process of identification of code generating unit 103 (step 303) is now described with reference to the flowchart of Fig. 5, which illustrates the process performed by identification code generating unit 103.

[0071] Identification code generating unit 103 prepares, as attribute information unique to the reproduc-

tion equipment, an identification code from or by combining the equipment ID of the reproduction equipment, the card ID of an IC card connected to the reproduction equipment, the user ID of a user, the raw material ID of the audio/visual signals, the medium ID of the recording medium in which the audio/visual signals are stored, and the reproduction date and time (step 401).

[0072] For example, the equipment ID of the reproduction equipment may be set to "152". In this example, the number "152" is used as the identification code.

[0073] This identification code is then converted into a binary bit string consisting of "0"s and "1"s (step 402). When the equipment code "152" is converted into a bit string, it becomes "10011000".

[0074] The signal sequences corresponding to the bit positions of the bit-converted identification code at which the bit value is 1 are searched from a previously prepared correspondence table (step 403).

[0075] Fig. 6 shows a correspondence table of the identification code bit positions and the signal sequences. Fig. 7 shows the identification code bit positions.

[0076] With the bit-string-converted identification code, "10011000", since the 4th bit, 5th bit, and 8th bit (reading from right to left) from the LSB take on a value of "1", the three signal sequences {N4, N5, N8} are found to correspond to the bit positions with a value of "1" by use of the correspondence table. Identification code generating unit 103 sends these signal sequences to digital watermark embedding unit 104 (step 404).

[0077] Although the identification code was converted to binary form in converting the identification code into a bit string, the method of conversion to a bit string is not limited thereto. For example, a code table for the ASCII code, etc. may be used instead.

[0078] Also, although signal sequences were prepared from bit positions of value "1" in the search for signal sequences from the correspondence table, the signal sequences may be prepared from bit positions of value "0" instead.

[0079] The process of digital watermark embedding unit 104 (step 304) is now described with reference to the flowchart of Fig. 8, which shows the flow of the process of the digital watermark embedding unit 104. Digital watermark embedding unit 104 embeds the plurality of signal sequences input from identification code generating unit 103 at the same proportion per fixed time T . This is done since the signal sequences can then be taken out conveniently at fixed proportions when audio/visual signals of a fixed time T are taken out.

[0080] That is, the number of times $EMAX$ by which each signal sequences is embedded in a fixed time T is set (step 701) and the number of times of embedding of each signal sequences is cleared to 0 (step 702).

[0081] One of the signal sequences is then selected randomly from among the signal sequences for which the number of times of embedding is not $EMAX$ and the number of times of embedding of that signal sequences is incremented (step 703).

[0082] The selected signal sequence is then embedded as a digital watermark by a previously used method into a predetermined unit of the audio/visual signals input from decoding unit 102 (step 704).

[0083] The processes from the selection of signal sequences of step 703 are then repeated until the number of times of embedding equals EMAX for all signal sequences. Then the next process is entered (step 705).

[0084] If the embedding process of step 703 to step 705 is to be repeated further, the process is repeated from the clearing of the number of times of embedding of step 702. otherwise the embedding process is ended (step 706).

[0085] Output unit 105 then outputs the audio/visual signals, in which the identification code has been embedded as the digital watermark by digital watermark embedding unit 104, to a monitor, speaker, recording equipment, network, etc. (step 305).

[0086] Referring now to Fig. 9, an example is shown in which the signal sequences have been embedded in video signals. With this example, the embedded signal sequences are {N4, N5, N8}, the unit of the video signals in which one signal sequences is embedded (the above-mentioned predetermined unit) is one field, the fixed time T in which the proportions of the respective signal sequences are made the same is set to 9 fields, and each signal sequences is embedded 3 times within the 9 fields.

[0087] Although one signal sequences is embedded within 1 field as the predetermined unit in this example, the predetermined unit may be set to 1 frame or the predetermined unit may be set to several fields or several frames.

[0088] Referring now to the flowchart of Fig. 10, the reproduction equipment identification method, by which the identification code is extracted from the audio/visual signals, in which the identification code was embedded as the digital watermark, and the reproduction equipment identified thereby, is shown. Fig. 10 illustrates the process performed by the reproduction equipment identification apparatus of Fig. 3.

[0089] Input unit 201 sends the input audio/visual signals to correlation value calculation unit 203 upon dividing the signals into the predetermined units, in each of which is embedded one signal sequence (step 901). Signal sequences recording unit 202 has recorded therein a correspondence table of identification code bit positions and signal sequences of the same contents as that used in the reproduction equipment.

[0090] Correlation value calculation unit 203 determines the correlation values of all signal sequences in the audio/visual signals input from input unit 201 and determines the maximum correlation value from these correlation values (step 902). The maximum correlation value and the bit position corresponding to the signal sequences for which the maximum correlation value was extracted are then sent to comparison unit 205.

[0091] For example, when the correspondence table

of Fig. 6 is used, correlation value calculation unit 203 determines the correlation values of the m signal sequences {N1, N2, ..., Nm} in the audio/visual signals and determines the maximum correlation value from among these correlation values. If the maximum correlation value SMAX is obtained for the correlation with the signal sequence {N4}, this maximum correlation value SMAX and the bit position {4} that corresponds to signal sequence {N4} are sent to comparison unit 205.

[0092] Threshold value setting unit 204 then sets a threshold value for the correlation value of comparison unit 205 (step 903). Comparison unit 205 then compares the maximum correlation value with the threshold value (step 904) and, if the correlation value exceeds the threshold value, sends the bit position corresponding to the signal sequences for which this correlation value was extracted to identification code judgment unit 206. If the maximum correlation value is less than or equal to the threshold value, the bit positions are not sent.

[0093] When a disturbance occurs due to illegal copying, etc., a correlation value greater than the threshold value may not exist at all or a plurality of correlation values greater than the threshold value may exist. In such a case, comparison unit 205 may be programmed to not compare the threshold value and the correlation value but perform, as an exceptional process, the extraction of the bit position of a signal sequence with a maximum correlation value S1 only in the case where the maximum correlation value S1 satisfies a certain condition with respect to the other correlation values Sn (for example, the condition $S1 > Sn$).

[0094] The process of identification code judgment unit 206 (step 905) is now described in detail with reference to the flowchart of Fig. 11 which shows the process of identification code judgment unit 206.

[0095] Identification code judgment unit 206 holds a plurality of bit positions that were obtained by determining the correlation with a plurality of signal sequences obtained from audio/visual signals of a fixed time T or more using at least the reproduction equipment (step 1001). An identification code bit string is then generated from the plurality of bit positions (step 1002). An identification code is generated from the bit string (step 1003).

[0096] The interpretation and method of bit string preparation and identification code generation are the same as those for the reproduction equipment. For example, if the plurality of bit positions obtained from an audio/visual signal of a fixed time T is {4, 5, 8}, since signal sequences are embedded at bit positions corresponding to the "1"s in the identification code bit string by the reproduction equipment, the bit string, "10011000", will be obtained.

Also, since decimal to binary conversion is used in the generation of the bit string at the reproduction equipment, the identification code, "152", will be obtained from the bit string, "10011000".

[0097] Identification code output part 207 then outputs the identification code extracted by identification

code judgment unit 206 (step 906).

[0098] Also in accordance with a correspondence table changing signal, the identification code generating unit 103 of the reproduction equipment and the signal sequence recording unit 202 of the reproduction equipment identifying apparatus can change the contents of the correspondence tables held. Such a change of the correspondence tables can be accomplished by any method. Several correspondence tables may be held in advance in each of identification code generating unit 103 and signal sequence recording unit 202. These correspondence tables may be interchanged, or a new correspondence table may be input from outside sources.

[0099] The changes of the correspondence tables in identification code generating unit 103 and signal sequence recording unit 202 are made simultaneously so as to make their contents agree.

[0100] Thus even for the same identification code, different signal sequences can be embedded as the digital watermark in the audio/visual signals at the reproduction equipment. The reproduction equipment identifying apparatus can thus be made to extract the embedded identification code correctly.

[0101] Also, as the plurality of signal sequences used in the correspondence tables in the identification code generating unit 103 of the reproduction equipment and the signal sequence recording unit 202 of the reproduction equipment identifying apparatus, signal sequence are used with which the cross correlation will be smaller than a previously set value (threshold value of cross correlation). By selecting a signal sequence in which the cross correlation is smaller, the precision of extraction of the embedded signal sequences can be improved and the precision of extraction of the identification code can be improved. Preferably, a PN code, M-sequence code, or Gold code is used.

[0102] As has been described above, with the reproduction equipment of the present embodiment, the decoding of coded audio/visual signals is performed, an identification code is converted into a plurality of signal sequences using a correspondence table, and the plurality of signal sequences thus obtained are embedded as a digital watermark at the same proportion per fixed time T.

[0103] Meanwhile, with the reproduction equipment identifying apparatus, the correlation values of the audio/visual signals in which the digital watermark was embedded and signal sequences contained in the correspondence table are determined and compared with a previously set threshold value to determine the validity of the embedded signal sequences.

[0104] The identification code of the reproduction equipment is then extracted from the plurality of signal sequences obtained from audio/visual signals of a fixed time T or more.

[0105] Furthermore, the correspondence tables in the reproduction equipment and the reproduction equipment identification apparatus are changed simultane-

ously to the same contents. The signal sequences to be embedded can thus be changed even for the same identification code.

Claims

1. Audio/visual reproduction equipment **characterised in that** it has a digital watermark generating means (32) including means for generating a digital watermark containing attribute information that identifies the reproduction equipment; a digital watermark embedding means (33) including means for generating watermark-embedded audio/visual signals which embeds said digital watermark in said audio/visual signals; and output means (34) for outputting said watermark-embedded audio/visual signals for reproduction.
2. Audio/visual reproduction equipment comprising a coded signal input unit (101) for receiving coded audio/visual signals; a decoding unit (102) including means for reproducing said audio/visual signals from said coded signal input unit; an identification code generating unit (103) including means for generating an identification code by which the reproduction equipment can be identified; a digital watermark embedding unit (104) including means for embedding said identification code as a digital watermark in said audio/visual signals input from said decoding unit (102); and an output unit, which outputs audio/visual signals having said digital watermark embedded therein by said digital watermark embedding unit (104).
3. Audio/visual reproduction equipment according to Claim 2, **characterised in that**, the said identification code is at least one of an equipment ID of the said reproduction equipment, a card ID of an IC card connected to the said reproduction equipment, a user ID of a user of the reproduction equipment, a raw material ID of said audio/visual signals, a medium ID of a recording medium on which said audio/visual signals are stored, a reproduction date and/or time, and/or an initial value of a signal sequence to be embedded as the said digital watermark.
4. Audio/visual reproduction equipment according to Claim 2 or Claim 3, **characterised in that** an output of said identification code generating unit (103) includes a plurality of signal sequences, and a table of correspondence of character strings and/or numbers which express identification codes, and means for employing a correspondence table for selection of said signal sequences.
5. Audio/visual reproduction equipment according to any of Claims 2 to 4, **characterised in that** it further

comprises means for converting said identification code into a binary bit string; and

means for selecting a plurality of signal sequences, which correspond to the positions of the converted bit string that take on a specific value.

6. Audio/visual reproduction equipment according to any of Claims 2 to 4, **characterised in that** said plurality of signal sequences are signal sequences with which cross correlation values are smaller than a previously set threshold value.

7. Audio/visual reproduction equipment according to any of Claims 2 to 4, **characterised in that** said digital watermark embedding unit (104) embeds a different signal sequence in each predetermined segment of said audio/visual signals.

8. Audio/visual reproduction according to any of Claims 2 to 7, **characterised in that** said digital watermark embedding unit (104) embeds a plurality of signal sequences, to be embedded as the digital watermark, randomly in the same proportion per fixed time in said audio/visual signals.

9. Audio/visual reproduction equipment according to any preceding claim, **characterised in that** it further comprises means (4) for recording a copy of said watermark-embedded audio/visual signals that are output by said reproduction equipment.

10. Audio/visual reproduction equipment identification apparatus comprising:

an input unit (201) for inputting audio/visual signals containing an identification code embedded therein as a digital watermark; a signal sequences recording unit (202) including means for holding a correspondence table of the same contents as that of reproduction equipment; a correlation value calculation unit (202) including means for calculating correlation values of input audio/visual signals and all of said signal sequences contained in said correspondence table and for outputting a maximum correlation value among correlation values obtained; a threshold value setting unit (204) including means for setting a threshold value for said correlation values; a comparison unit (205) including means for comparing said maximum correlation value with said threshold value, and for outputting one of said signal sequences for which said maximum correlation value exceeds said threshold value; an identification code judgment unit (206) including means for determining an identification code in accordance with said signal sequences output from said comparison unit (205) and said correspond-

ence table; and an identification code output unit (207) including means for outputting said identification code.

11. Audio/visual reproduction equipment identification system comprising:

audio/visual reproduction equipment (3); audio/visual reproduction equipment identification apparatus including means for generating attribute information that enables identification of at least one attribute of said audio/visual reproduction equipment; means in both said audio/visual reproduction equipment and said audio/visual reproduction equipment identification apparatus for containing said attribute information; said audio/visual reproduction equipment including means for embedding said attribute information in an audio/visual signal as a digital watermark that enables identification of said reproduction equipment; and said reproduction equipment identification apparatus including means for extracting said digital watermark embedded in said audio/visual signal and for identifying said reproduction equipment associated with said audio/visual signal based on the extracted digital watermark.

12. A method of reproducing audio/visual signals, comprising the steps of:

generating a digital watermark, containing attribute information that enables identification of audio/visual reproduction equipment; embedding said digital watermark in audio/visual signals to produce watermark-embedded audio/visual signals; and outputting said watermark-embedded audio/visual signals.

13. A method of reproducing audio/visual signals, comprising: inputting coded audio/visual signals; decoding said coded audio/visual signals to reproduce said coded audio/visual signals; generating an identification code; embedding a digital watermark containing said identification code in said input audio/visual signals; and outputting said audio/visual signals containing said digital watermark.

14. A method of reproducing audio/visual signals according to Claim 13, **characterised in that** said identification code is at least one of an equipment ID of audio/visual reproduction equipment, a card ID of an IC card connected to said audio/visual reproduction equipment, a user ID of a user, a raw material ID of said audio/visual signals, a medium ID of a recording medium on which said audio/visual signals are stored, a reproduction date and time, and/or an initial value of a signal sequence to be

embedded as said digital watermark.

15. A method according to Claim 13, **characterised in that:** the step of generating an identification code includes using a plurality of signal sequences, and a table of correspondence of at least one of character strings and numbers that express identification codes to select a one of said plurality of said signal sequences.

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16. A method according to Claim 15, **characterised in that** it further comprises:

converting said identification code into a binary bit string; and selecting a plurality of signal sequences, which correspond to positions of said converted bit string that take on a specific value.

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17. A method according to Claim 15, **characterised in that** the plurality of signal sequences are signal sequences having cross correlation values that are smaller than a previously set threshold value.

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18. A method according to Claim 15, **characterised in that** the step of embedding includes embedding a different signal sequence in each of a predetermined section of the audio/visual signals.

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19. A method according to Claim 18, **characterised in that** the step of embedding includes embedding said plurality of signal sequences randomly at the same proportions per fixed time in said audio/visual signals.

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20. A recording medium, **characterised in that** watermark-embedded audio/visual signals are recorded by the reproduction method of claim 12.
21. A method of identifying audio/visual reproduction equipment, **characterised in that** it comprises: inputting audio/visual signals containing an identification code embedded therein as a digital watermark; holding a correspondence table of the same contents as that in audio/visual reproduction equipment, calculating correlation values of the input audio/visual signals and all signal sequences included in said correspondence table and outputting a maximum correlation value among said correlation values; setting a threshold value for said correlation values; comparing said maximum correlation value with said threshold value and outputting a one of said signal sequences for which said maximum correlation value exceeds said threshold value; determining an identification code in accordance with said one of said signal sequences with contents of said correspondence table; and outputting said determined identification code.

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Fig. 1

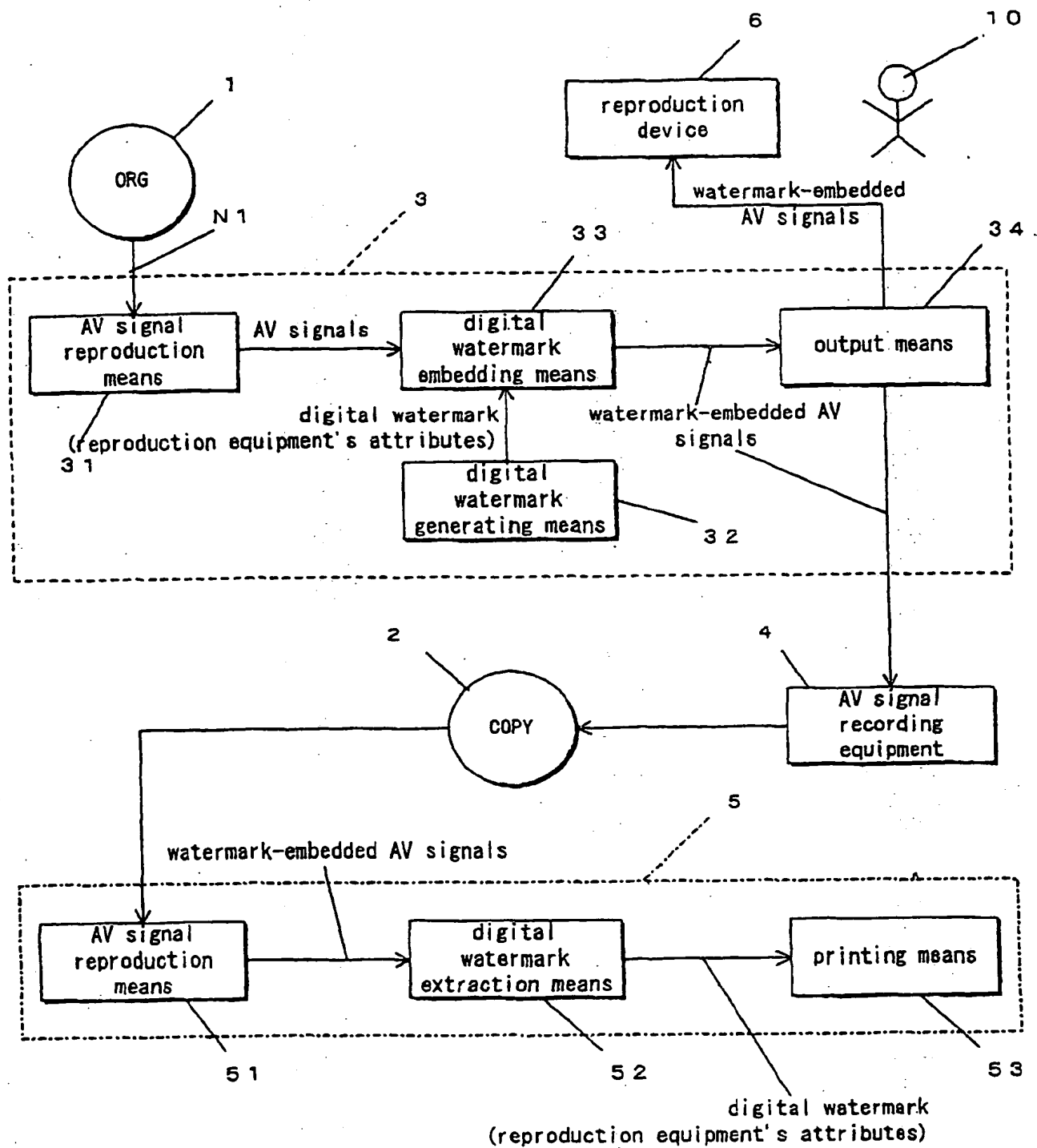


Fig. 4

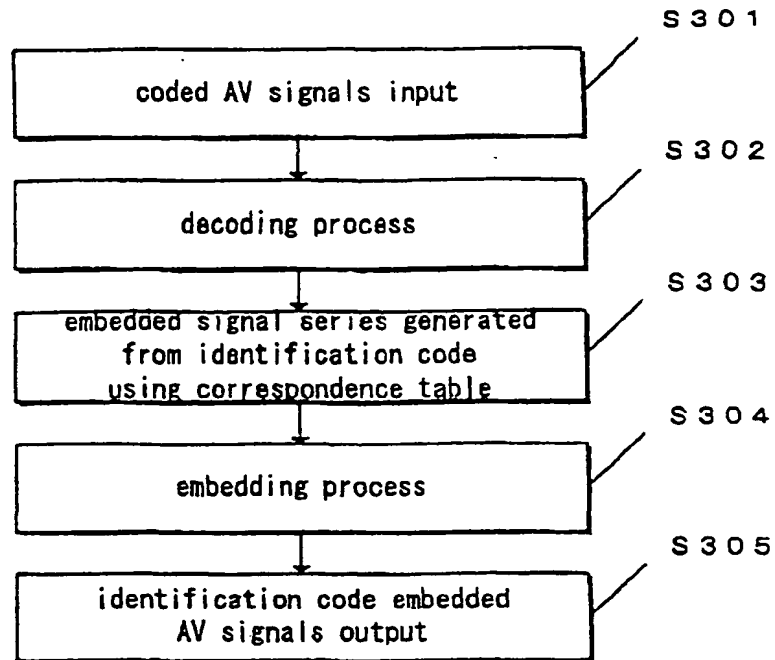


Fig. 5

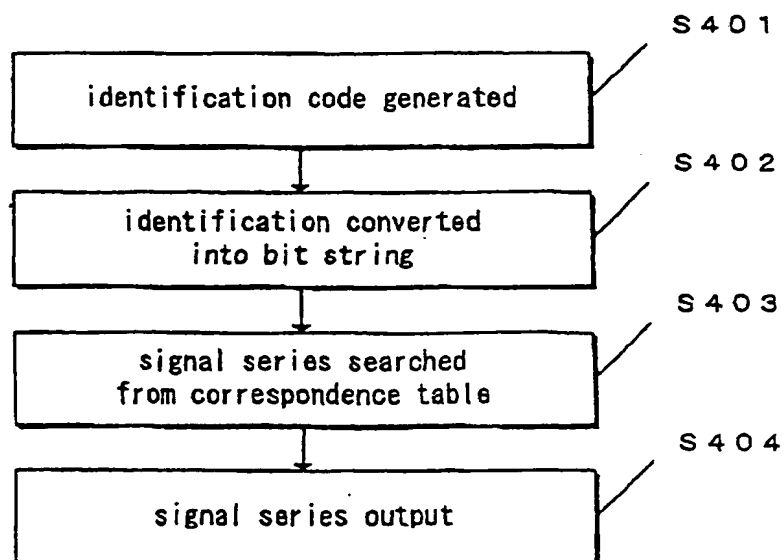


Fig. 3

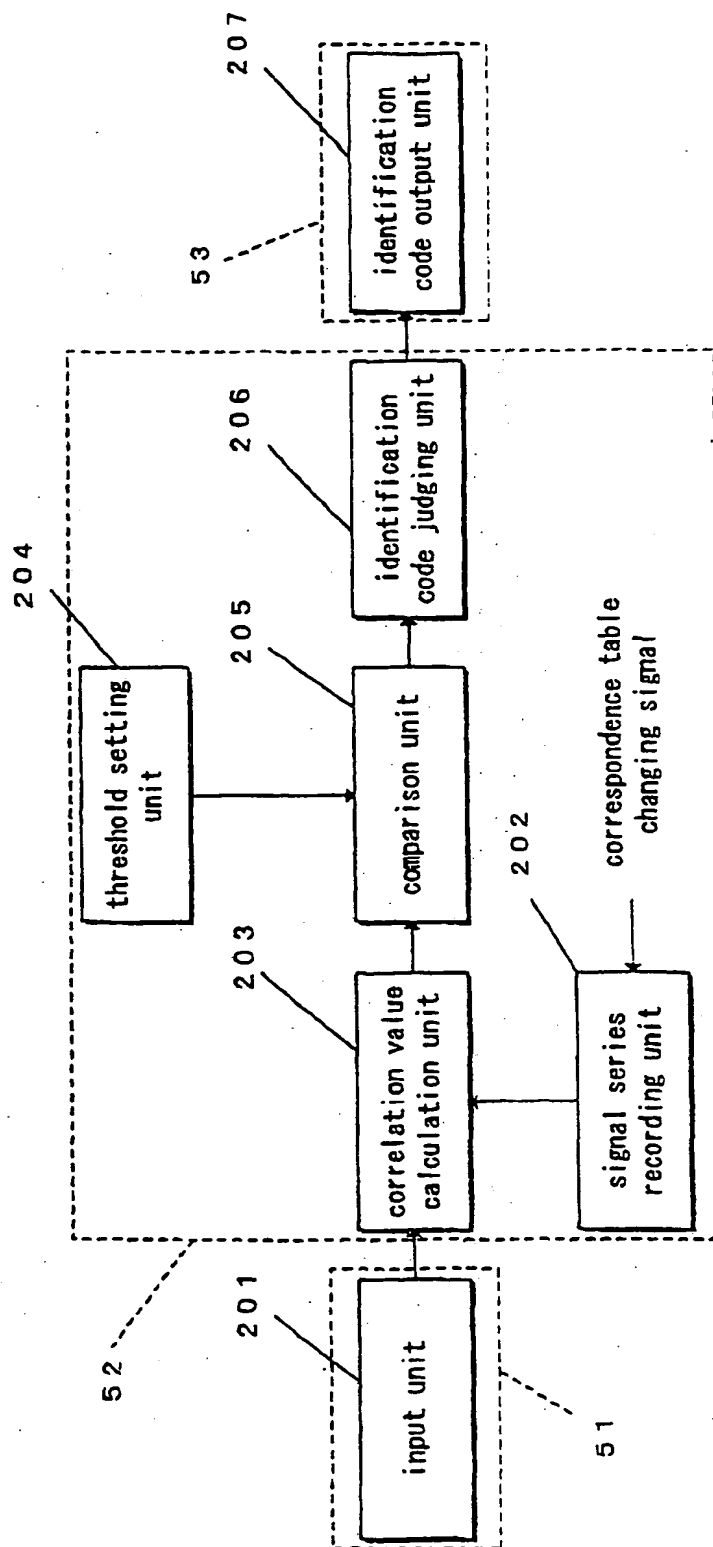


Fig. 2

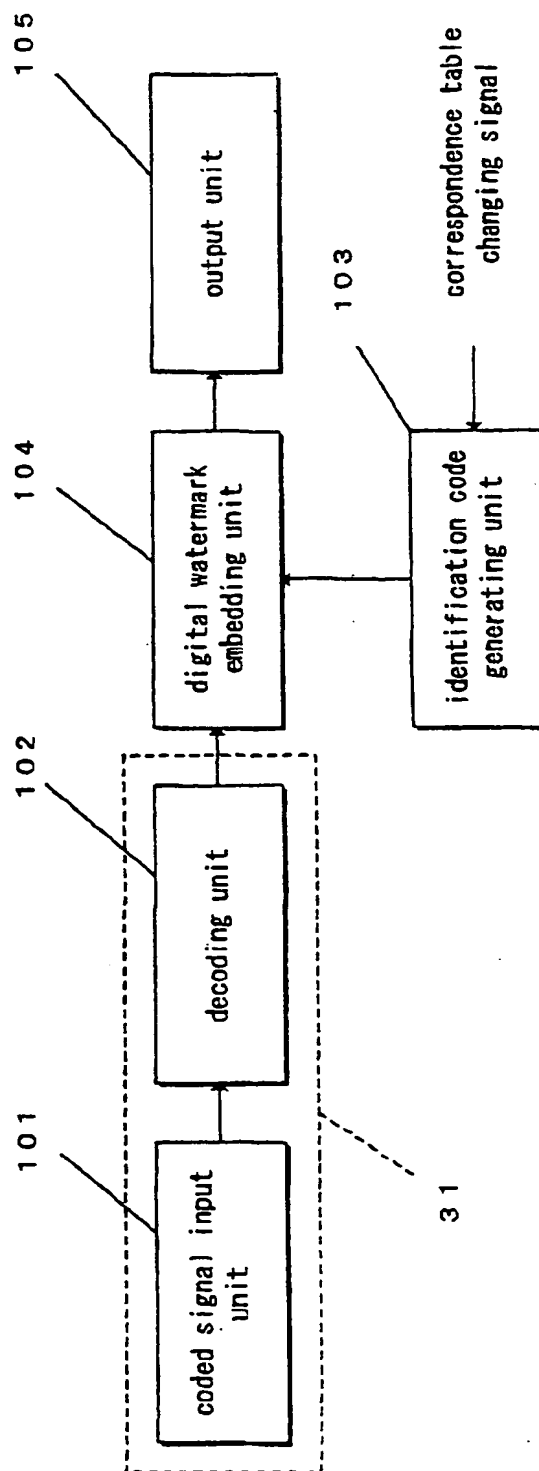


Fig. 6

bit position: j	signal series
1	N 1
2	N 2
3	N 3
⋮	⋮
m	N m

Fig. 7

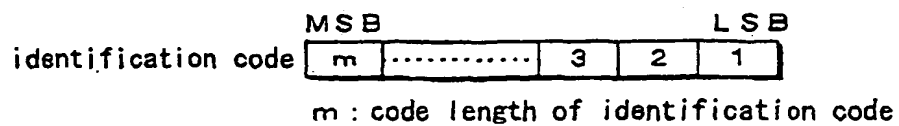


Fig. 8

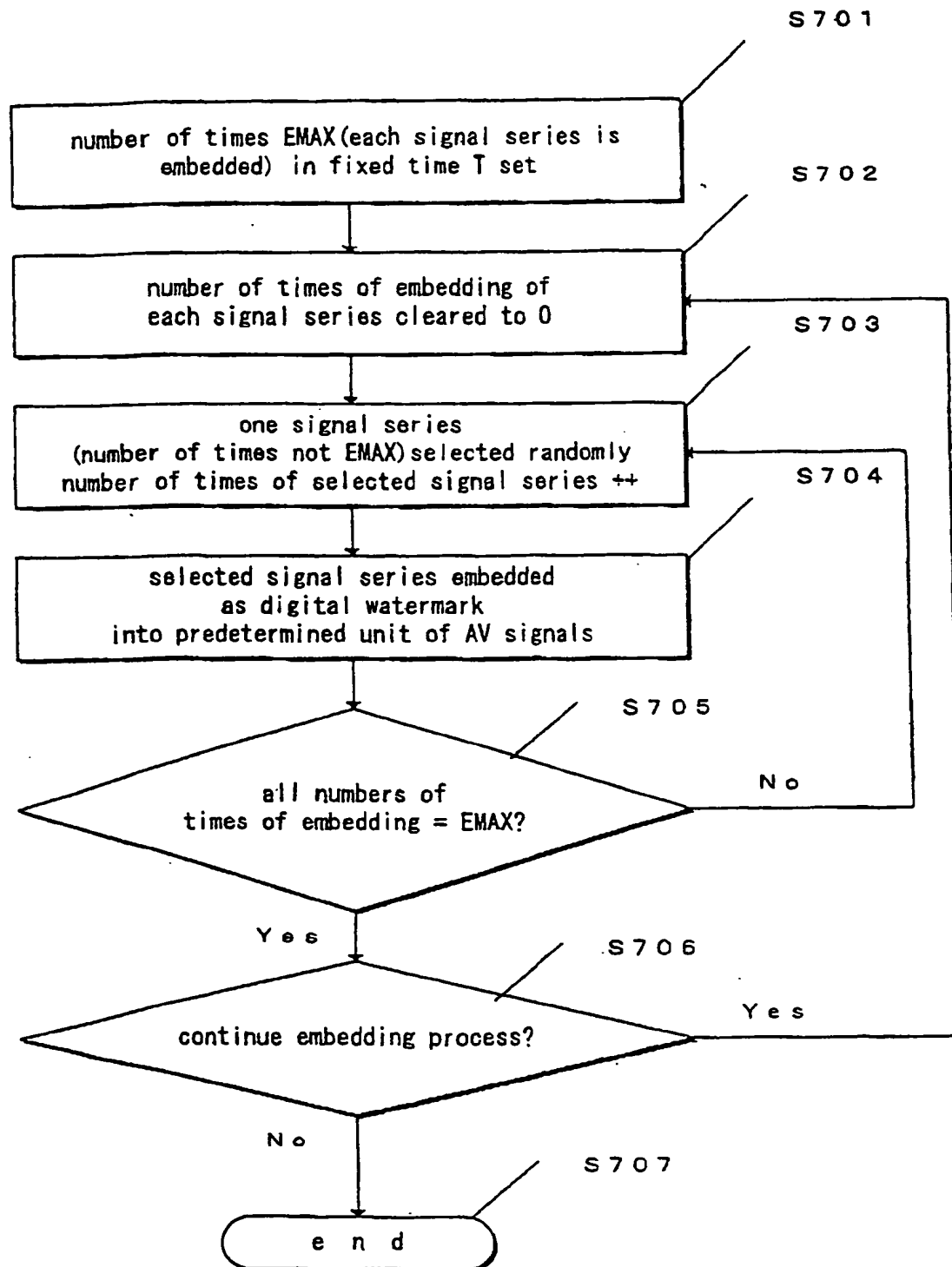


Fig. 9

signal series = {N4, N5, N8}
 predetermined unit = 1 field
 fixed time T = time within 9 fields
 EMa x = 3

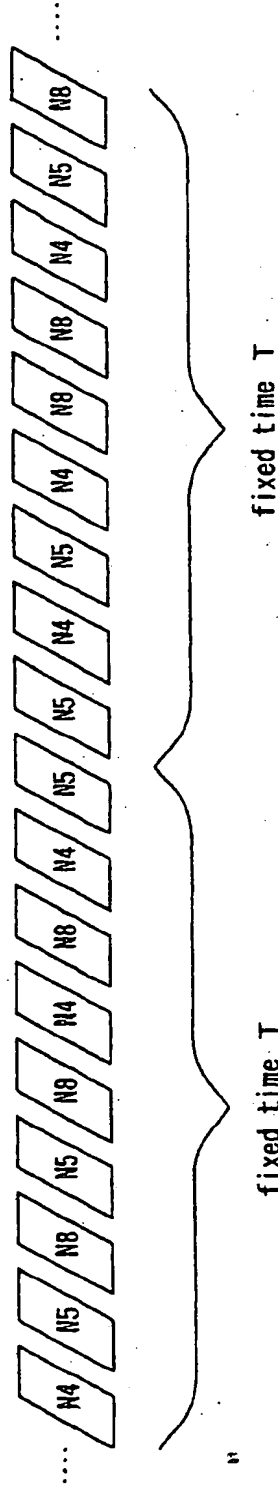


Fig. 10

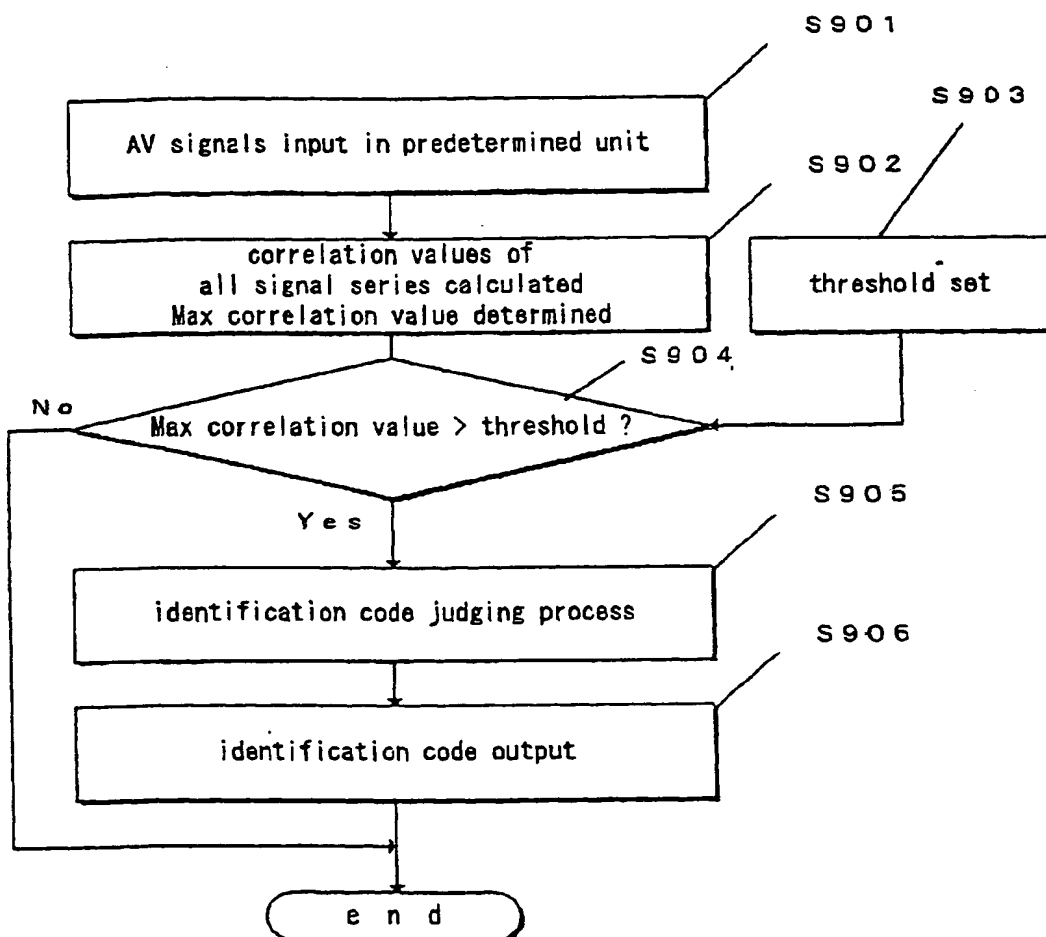
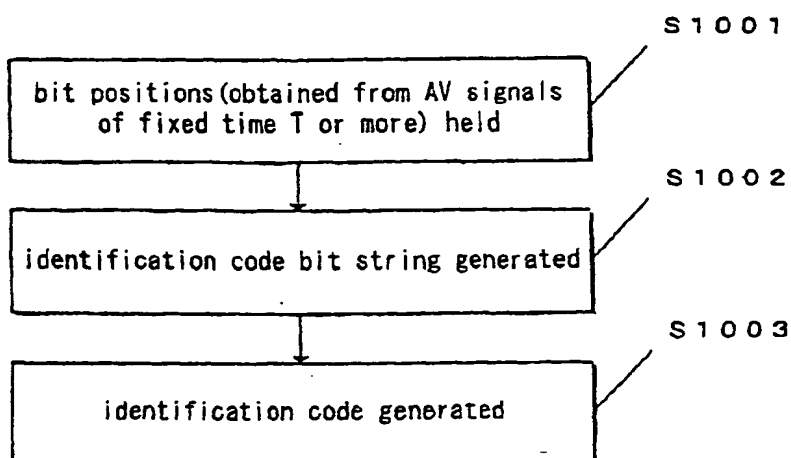
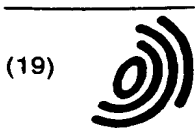


Fig. 11





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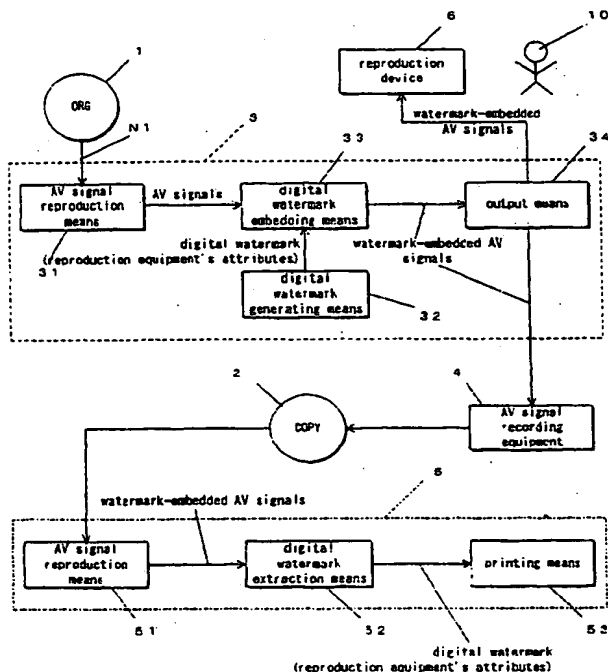
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(54) Audio/visual reproduction apparatus and method with equipment identification code insertion

(57) Audio/visual reproduction equipment (3) converts an identification code of the reproduction equipment into a plurality of signal sequences using a correspondence table and embeds the obtained plurality of signal sequences in audio/visual signals as a digital watermark. Audio/visual reproduction equipment identification apparatus compares correlation values of the audio/visual signals containing the digital watermark embedded therein with all signal sequences contained in a correspondence table. A comparison of the correlation values with a previously set threshold value determines the embedded signal sequences and thus the identification code of the audio/visual reproduction equipment which may be extracted.

Fig. 1





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The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 28 January 2003	Examiner Dudley, C
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